Calender

~~The present invention relates to a calender according to the preamble of claim 1 and a calendering method according to the preamble of claim 8.~~

Conventionally, the surface of a moving web of paper or board is smoothed and made glossy in a multiroll calender comprising a plurality of rolls stacked in a calender frame so as to form a nip contact with each other. The roll stack comprises a top roll and a bottom roll with at least one intermediate roll located therebetween. The rolls of the stack are compressed against each other by the top and bottom rolls that act as the loading rolls or, simply, by the bottom roll to provide a sufficiently high linear nip force. In calendering, the web passes through the calender nips formed by the superimposed rolls.

The rolls of the calender stack are mounted rotatably in bearing blocks that are usually attached to roll mounts. The roll mounts themselves are slidably connected to vertical guides adapted to the calender frame. In a conventional supercalender, the roll mounts are additionally connected to vertical screw jack assemblies adapted to the calender frame. When the roll stack is open, the positioning of the roll mounts in the vertical direction is accomplished by means of the jack assemblies comprising threaded screw rods and nuts running thereon. As each one of the mounts of the roll bearings rest on these jack nuts, the entire weight of the set of rolls is supported on the screw rods when the roll stack is

unloaded. Bearing blocks of roll stack and thereby the rolls mounted thereon can be moved vertically in regard to the mounts.

The roll set of a multiroll calender has a plurality of rolls in a superimposed disposition, whereby the linear load imposed on the nips by the weights of the rolls increases nip-by-nip from the top nip to bottom nip, whereby the linear load in the bottom nip is the maximum stress imposed by the calender on the web passing the calender. Hence, the calender must be designed based on the load-bearing ability of the bottom nip, whereby a substantial portion of the potential calendering capacity of the upper nips remains unused. Also the weights of the roll bearing blocks and auxiliary devices connected thereto cause distortion in the linear pressure profiles of the nips, particularly at the nip ends, thus deteriorating the quality of the calendered web.

One technique developed for equalizing the nip loading is the so-called variable-crown calender, wherein the weights of the intermediate rolls do not essentially contribute to the linear load in the nips. In calenders equipped with variable-crown roll, the intermediate rolls of the stack are provided with load-relieving devices such as hydraulic load-relief cylinders or pivotal links connected to the calender frame, by means of which arrangements the linear load imposed by the intermediate rolls and auxiliary devices connected thereto can be relieved, thus allowing the nips to be loaded mainly by the variable-crown top and bottom rolls or, alternatively, an external load imposed on said rolls. In a load-relief

system for the intermediate rolls, the design factors to be taken into account are the deflection stiffness, mass, shape and material properties of each roll. The support forces to be imposed on the intermediate rolls are varied with the help of the load-relief means so that the roll set is equilibrated and brought to a desired state of crowning. Variable-crown calenders are described, among other things, in US Pat. No. 5,438,920.

It is an object of the present invention to provide an entirely novel type of calender construction capable of relieving the linear loads imposed on the calender nips by the weights of the roll masses.

The goal of the invention is achieved by way of disposing actuator means such as springs or hydraulic cylinders between the mounts of each superimposed pair of rolls so as to relieve the linear load of the nips. Within the constraints of available space, the actuator means may also be placed between the bearing blocks of two superimposed rolls forming a nip. If so needed, the cylinder portion of the hydraulic cylinder and the hydraulic fluid channels may be machined into the interior of the bearing blocks or their mounts.

The invention offers significant benefits.

In a calender according to the invention, the linear load of the nips may be relieved, whereby the loading imposed by the upper nips on the web can be increased, thus achieving a higher calendering capacity and improved quality of web calendering. A calender implemented ac-

cording to the invention has a simple construction. For instance, it needs no threaded screws and nuts conventionally used in the position adjustment jacks of rolls inasmuch the rolls are separated from each other with the help of actuator means so that the rolls are displaced apart from each other by the distance of the quick-opening gap when the roll stack is unloaded. As the loading of nips can be relieved individually, the web being calendered can be treated single-sidedly by loading, e.g., the top and bottom rolls of a reversing nip by unequal forces. Furthermore, existing calenders can be readily and cost-efficiently modernized into a calender according to the invention.

More specifically, the calender according to the invention is characterized by what is stated in the characterizing part of claim 1.

Furthermore, the calendering method according to the invention is characterized by what is stated in the characterizing part of claim 8.

In the following, the invention will be examined in more detail by making reference to the appended drawings.

FIG. 1 shows diagrammatically a calender according to the invention.

FIG. 2 shows diagrammatically another calender according to the invention.

Referring to FIG. 1, the calender construction shown

therein comprises a top roll 1 and a variable-crown bottom roll 2 having therebetween adapted intermediate rolls 3 of an intermediate roll set. The number of the intermediate rolls 3 is at least one. The rolls 1, 2, 3 are mounted on bearing blocks 4 that are further connected to mounts 5. The mounts 5 are slidably connected to guides 7 adapted on the calender frame 6. The roll set is moved and the load pressures of the nips formed between the rolls 1, 2, 3 is adjusted with the help of actuators such as loading cylinders 8 adapted to the calender frame 6 so as to impose the loading forces on the top roll 1 and the bottom roll 2. During calendering, the web passes the nips formed by the superimposed rolls.

Between the mounts 5 of the rolls forming the nip between two superimposed rolls, there are provided springs 9 such as a stack of cup springs, acting as actuators so as to relieve the linear loading of the nips caused by the weights of the rolls and the auxiliary devices connected thereto. Provided that a sufficient operating space is available, the springs 9 may alternatively be placed between the bearing blocks 4 of superimposed rolls forming a nip. If a complete elimination of the linear loading caused by the rolls and their auxiliary devices on the nips is desirable, the springs 9 must be dimensioned so that their spring constant and length or, alternatively, the number of cup springs in a single stack of cup springs is selected such that the spring system 9 adapted between each mount 5 and/or bearing block 4 can support the weight of its overlying rolls and their auxiliary devices. Then, the spring constants are selected such that the spring system located between the

mounts 5 of rolls 2, 3 forming the bottom nip has the highest spring constant, while the spring system located between the mounts 5 of rolls 1, 3 forming the top nip is selected to have the lowest spring constant. When the rolls 1, 2, 3 are not loaded by the loading cylinders 8, the springs 9 keep the rolls 1, 2, 3 separated at a distance of the quick-opening gap from each other. Additionally, the springs 9 must have some degree of overcompressibility to prevent them from bottoming during the loading of the roll set.

To keep the loading of the nips maximally equal, the springs 9 must be dimensioned so as to make all the nips to close simultaneously when loading is applied on the nips. Hence, the springs 9 of a smaller spring constant placed between the mounts 5 of the rolls forming the upper nips must respectively have a longer working travel. Alternatively, the system can be constructed using progressive springs in which the spring constant changes with the travel.

The quick-opening of the calender nips is accomplished by way of removing the loading imposed by the loading cylinders 8, whereby the springs 9 placed between the mounts 5 can separate the rolls 1, 2, 3 apart from each other. The gap width of the quick-opened nips can be changed by, e.g., varying the number of cup springs in the assembled spring stack.

In the embodiment of FIG. 2, there are no springs 9 located between the mounts 5 of the rolls forming a nip, but rather, hydraulic cylinders 19 are used as the actua-

tor means. Herein, the gap width of the quick-opened nips and the nip loading forces can be adjusted with the help of the hydraulic cylinders 19 by means of changing the pressure of the hydraulic fluid. Otherwise the embodiment of FIG. 2 is basically identical to that shown in FIG. 1. Also the hydraulic cylinders 19 may be located, within the space constraints, between the bearing blocks 4 of superimposed rolls 1, 2, 3 forming a nip. To save space, the cylinder portion of the hydraulic cylinder 19 and the hydraulic fluid channels communicating therewith may be machined directly into the interior of the mounts 5 or the bearing blocks 4.

In addition to those described above, the invention may have alternative embodiments.

When necessary, the loading of certain nips may be relieved by a greater amount than the loading of certain others, whereby it is possible within the constraints of the allowable deflections of rolls 1, 2, 3 to affect the degree of single-sidedness of the calendered web.

The top roll 1 and/or the bottom roll 2 may be connected by their bearing blocks 4 to the guides 7, rather than by their mounts as taught above. The top roll 1 or the bottom roll 2 of the calender can be solidly connected by its mounts 5 or bearing blocks 4 to the calender frame 6 or its guides 7. In this arrangement, the fixed rolls 1, 2 need not be provided with loading cylinders 8, but rather, the entire roll set of the stack can be simply loaded with the help of the loading cylinders 8 acting on the other roll 1, 2 adapted movable along the guides 7.